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ABSTRACT

A research study investigated the validity of directly interfacing an uninitiated user with a complex, computerized batch processing system via a conversational, interactive language. A control group conducted mediated searches of the Educational Resources Information Center's (ERIC) files by consulting with an information specialist. Members of the experimental group directly conducted their own searches, after undergoing training with the ERIC/QUERY Interface Program (EQUIP), a computer-assisted instructional training package. Results showed that: 1) the choice of interface methodology (mediated or direct) did not influence the user's satisfaction with the search; 2) there was no relation between the user's knowledge of the system and his satisfaction with it; 3) those trained by EQUIP showed significant increases in their ability to conduct computer searches of ERIC; and 4) there was no predictive relationship between the user's knowledge of the system and the precision of the resulting search, thus indicating that the system was less than ideal. (PB)

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A STUDY OF A DIRECT INTERFACE OF THE NOVICE USER TO A COMPLEX BATCH PROCESSED COMPUTER APPLICATION

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INTRODUCTION

All too often, whether the average educator likes it or not, he is literally at the mercy of computer programmers, system analysis and the other "data processing types" in his quest to use the digital computer as a viable tool. It was not until the recent acceleration of the state-of-the-art of the computer industry that a "layman" educator could productively use the computer without the imposition of the expected interface of either learning programming or employing a "computer type" to do it for him. One such advance is the interactive (conversational) service that is rapidly becoming available within a feasible price structure.

The conversational services under consideration is not unlike the IBM, supported A Programming Language (APL) which has enjoyed increasing success on a national scope. What are not under consideration are specialized on-line packages that have a single purpose or application. Such specialized applications are still completely out of reach of the education community's budget.

The prime objective of the study reported in this paper was to investigate the validity of directly interfacing an uninitiated user ("layman" educator) with a complex, computerized batch processing system via a conversational, interactive language.

The Scope of the Study

Information is being produced by all disciplines at an increasing rate each year. In response to this phenomenon, the United States Office of Education (USOE) has committed millions of dollars of the nation's resources to the creation of the first national education information system, known as "ERIC" (Educational Resources Information Center), to assist the decision-maker, researcher, and practitioner assess a growing bank of documents for the education profession.

To aid the serious user in his document search and retrieval tasks, a computerized searching system known as QUERY was created and implemented in over a dozen installations across the nation in 1969. QUERY is a batch processing system which requires a unique "search language" as machine-readable input and offers almost unlimited document searching capabilities. Because of this distinctive characteristic, if one is to

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properly use the QUERY automated information system he must be able to select the correct search criterion prior to submitting his search request to the computer.

Until the accomplishment of this study, all "QUERY" installations accommodate the information seeker (user) by negotiating a search request. This normally required a conference between the user and an information specialist and was concluded when an acceptable search strategy (search language) based upon the user's expressed needs was recognized by the information specialist. This method of interfacing the system (through the information specialist) is less than satisfactory for a number of reasons including: (a) the difficulty the user has in expressing his specific search need to another person; (b) the size of the files often "overpowers" the unitiated user of the ERIC system; and (c) the highly technical search process cannot be completely explained to the user, thus his knowledge of the retrieval capabilities is severely limited.

The Objectives

The objectives of the study were:

(1) To develop, implement, and test a computer-assisted-instruction (CAI) package to train users of the computerized ERIC files to interface with the information retrieval system without the assistance of information or data processing specialists.

(2) To design an instrument to measure the system user's satisfaction with the results of computer searches resulting from either the specialists or from personal interface with an information retrieval system.

(3) To determine any differences between experimental and control groups of ERIC automated information retrieval system users -- with the experimental group undergoing CAI training and direct job submission and the control group receiving no such training.

The Hypotheses

The specific hypotheses tested included:

(1) There are no significant differences between the measured user satisfaction with computer search results of CAI-interfaced subjects and those undergoing search negotiations with an information specialist.

(2) There are no significant differences between the subjects' pre- and post measures of knowledge of the information retrieval system administered during the experimental CAI treatment.

(3) There is no significant relationship between measured knowledge of the ERIC automated information retrieval system acquired as a result of CAI training and user satisfaction as measured by the user satisfaction instrument.

The Basic Assumptions of the Study

The study was based on the following assumptions:

(1) Once an educator understands the utility of an information base especially designed and maintained for his discipline, he will attempt to capitalize upon the respective benefits of such a system.

(2) Potential user traits and skills will vary extensively; reading ability, typing ability, and educational level (i.e. educators vs. trainees) will differ.

(3) The ERIC information file size will not remain static; file size currently increases over one thousand documents per month (file size was held constant for the study).

(4) For the duration of the study, computer files, search programs, and listing formats will be unchanged.

(5) Measurement instruments are valid.

(6) Subjects have had no prior experience with ERIC automated retrieval systems.

Additionally, the QUERY information retrieval system, to be discussed later, is assumed to exist in a stable form.

A BRIEF REVIEW OF RELEVANT LITERATURE

General Systems Theory

General systems theory as described by Optner (10, p. 9) and Stufflebeam (12, p. 124) is concerned with two major characteristics -- input to the system and output from the system. When such systems involve computer usage they ". . . are structured, or designed, to operate in nonvariant, highly predictable ways Optner (10, P. 4)." It follows that if a highly structured system is not understood by its users, the efficacy of such a system will be less than design expectations.

This study attempted to show that, within the realm of information retrieval systems, the less knowledge the user of the system possesses about the system, the greater the chances the system will not operate within its designed purpose.

Decision Theory

It is worthy to note that the various decision-making theories of Kepner and Tregoe (7, p. 73), Griffiths (4, p. 90), Halpin (5, p. 35), and Meyer (9, vol. 1) each rely on the acquisition of information as a prelude to completing the decision-making process. Additionally, each process is described as a system or may be thought of in terms of general systems theory. Stufflebeam (12, p. 38) points out that the availability of information prior to selecting alternatives in decision-making is assumed. Thus, the importance of information within the context of educational decision-making may not be overlooked.

The Use of Information Retrieval Systems

The use of an automated retrieval system is anything but a simple matter. Lancaster (9, pp. 181-2) suggests that retrospective literature searches may be divided into those conducted without an intermediary by the person having the information need, and those delegated by this person to a second individual, usually a librarian or information specialist. Lancaster (8, pp. 182-5) clearly shows that there are different skills and expectations required of the requester under these two schemes. Additionally, he points out that twenty percent of the National Library of Medicine's Medical Literature Analysis and Retrieval System's searches involving defective interaction (between the user and the searcher) were judged to be of the type in which the requester, using an intermediary, was unable to precisely define his need except through some browsing in the literature (8, p. 184). To summarize, this means that to be successful the requester must spend a considerable amount of effort defining and negotiating his search request with the person who will actually encode the search in machine-readable form or learn how to use the system himself. The economics of the former appear to be less attractive than those of the latter.

Batch Processing Automated Information Retrieval Systems

Janda (6, p. 4) shows that in the fourteen years since the first published application to key word indexing of precoordinated information files by the computer, hundreds of batch processing information retrieval systems have been created.

The review of the literature shows that many batch processing information retrieval systems were either designed for highly specific applications and/or developed around available computer hardware and software.

The apparent advantages of the batch processing systems include:

(1) Systems designers may capitalize on their existing computer capabilities without added costs for additional software.

(2) Maximal specialization of the system may be facilitated, allowing for "tailor-made" systems which meet the designer's needs at the least cost.

(3) "In-house" created computer programs are maintained internally; thus changes to the system may be made with the fewest constraints.

Because of the advantages listed, it is unlikely that batch processing information retrieval systems (or many other types!) will be discontinued without some significant changes in the costs and "state of the art" of the computer industry.

It is noteworthy that, of all of the batch processing information retrieval systems investigated, none were accompanied with a system-to-user interface. All required the intervention of an intermediary, as cited by Lancaster (8, pp. 182-5).

The ERIC/QUERY Information Retrieval System

The Educational Resources Information Center (ERIC) retrieval system. The ERIC system was begun in 1965 with the production and dissemination of the Catalog of Selected Documents on the Disadvantaged, and since has grown into an international educational information retrieval system of considerable scope and complexity (1, pp. 58-63). Currently, ERIC files may be searched manually or via the computer using an on-line system called DIALOG or batch processing programs such as the USOE-sponsored QUERY system.

DIALOG is a highly specialized, on-line system and is not under consideration due to its impractical cost.

QUERY is an advanced, generalized, sequential, file-searching, batch processing computer software package, using RIE and CIJE magnetic tapes or disk files, which is capable of isolating and listing any informational subset, depending on the search strategy used (3).

CAI Studies

Although the literature abounds with studies, projects, and programs which use CAI as a training media, no CAI programs or studies are known to exist which specifically focus upon the problem of requester-to-system interface.

THE ERIC/QUERY INTERFACE PROGRAM (EQUIP)

Available literature clearly showed the existence of numerous batch processing information retrieval systems as well as an increasing number of on-line interactive systems. The investment of resources for batch processing systems will most likely insure their existence and maintenance for years to come. The on-line systems are gaining some popularity despite their cost, due in part to the ability to provide systems-to-users interface, a feature totally lacking with the more numerous, less costly batch processing systems. This phenomenon led to the present study.

Since no search interface package was known to exist, the author created EQUIP (ERIC/QUERY Interface Program), a CAI training and search submission package henceforth described.

The Program Language of EQUIP

IBM's popular telecommunication language, APL, was selected as the language to program EQUIP because of its immediate availability, versatility, and power as a CAI medium. The version of APL used was not standard, as supported by IBM, but instead has a unique feature provided through the efforts of Thomas H. Puckett of the New Mexico State University Computer Center. Dr. Puckett's modification of APL allows for the submission of the searches encoded by the user directly to the job stream of the IBM 360/65 multiprocessing computer job stream -- a feature not currently available in the IBM supported version of the language.

In addition, APL has been found to be efficient as related to computer time used for interface purposes. This characteristic coupled with some unique matrix operations and generic time-monitoring functions led to the decision to use APL, a pre-dedicated service, as the CAI program language for EQUIP.

The Objectives of EQUIP

The second and most important consideration relating to the creation of EQUIP was to determine a sound training foundation and minimum instructional objectives. This process relied heavily on the author's two years of experience while maintaining the QUERY system and processing automated searches for hundreds of users. Thus the central focus used in deriving minimal performance objectives for EQUIP are centered on the criteria: What is the minimum a novice user must learn for the implementation of a satisfactory computer search? Based on experiences with the system, the following guidelines were used.

(1) The user must understand the proper use and meaning of three standard reference sources -- the ERIC Thesaurus of Descriptors, the ERIC Rotated Thesaurus of Descriptors, and the ERIC Posting of Descriptor Statistics (a source of the number of times a particular descriptor is used by RIE).

(2) The user must be able to create a statement of his information need and subsequently reduce that statement to basic elemental descriptors.

(3) The user must be able to properly use descriptors to isolate the citations of interest from the ERIC information files.

(4) The user must understand and be able to correctly use the basic Boolean logic required in the QUERY search language.

(5) The user must be able to correctly encode a search in machine-readable language.

Since it was desired that the user-to-system interface program be suitable to individual differences (via CAI), other less important objectives were evident:

(1) The user must learn how to use the telecommunication terminal.
(2) The user must be aware of what the computer (QUERY) can and cannot do.

The Development of EQUIP

Based on the previously defined criteria, EQUIP was planned and written. Each subprogram was written and tested using both knowledgeable and novice subjects until the specific objectives of the subprograms were rewritten several times before they were deemed acceptable.

After subprograms and related support programs were written, tested, and accepted, the total package was assembled and tested using knowledgeable and novice users of ERIC/QUERY facilities. Necessary modifications were installed and then "polished" until EQUIP was considered ready for formal testing and comparison with existing search negotiations procedures.

An integral part of EQUIP is an eighteen-item pre- and post-test administered to the user in the course of his CAI training and subsequent search submission. The prime purpose for the pretest was that of switching (branching) the training sequence of the user with EQUIP, based on his knowledge of the ERIC system. It was assumed from the beginning that the skills and knowledge of users would vary widely. Through the use of the pretest switching provision of EQUIP, the training a particular user might

undergo was, essentially, individually prescribed based on what "he brings to the training session." It should be noted that the only major branching with EQUIP takes place as a result of the user's performance on the pre-test.

Accordingly, four major "blocks" of instruction, as presented below, were conceptualized.

Block one: system familiarization. The major purpose of this instructional block is to allow the user to learn the basic use of the APL telecommunication medium and some very basic concepts unique to computer systems. Internal subblocks and objectives are shown in the following table:

Table 1

Subblocks and Objectives of Block 1 of EQUIP

Subblocks	Objectives
Terminal Training	The user must demonstrate competency in using the IBM 2741 telecommunication terminal.
Keyboard Training	The user must demonstrate competency in using specific APL keyboard characters as well as knowledge of basic keyboard functions such as correcting mistakes.
Response Training	The user must show competency in responding in the correct manner to instructions, questions or commands used within EQUIP.
Pretest	A means of ascertaining the user's knowledge base relative to the QUERY automated information retrieval system must be provided.
Systems Training	The user must demonstrate a basic knowledge of simple computer input, output and processing concepts.
Computer Input Familiarization	The user is shown how the general search language (encoded) appears as input to QUERY.
Computer Output Familiarization	The user is invited to investigate sample listings of citations provided near the terminal.

Note.---With the exception of the last two subblocks, the user must demonstrate competencies prior to being advanced further in the session.

Block two: QUERY familiarization. The second major instructional block concentrates on the standard published materials deemed necessary to assist the user in his search construction. Table 2 depicts the subblocks and objectives of the second instructional block.

Table 2

Subblocks and Objectives of Block 2 of EQUIP

Subblocks	Objectives
File Familiarization	The user must show acceptable knowledge of the use of existing ERIC files and the relationship and usage of descriptors in isolating documents from a file.
Rotated Thesaurus Familiarization	The user must indicate that he has learned the use of the ERIC rotated thesaurus and its application to modified descriptors.
Descriptor Statistics Usage	The user must demonstrate knowledge and use of the ERIC descriptor reports, a resource material which aides in predicting the number of possible search hits.
Thesaurus Usage and Familiarization	The user must demonstrate the ability to use descriptors, as given in the ERIC thesaurus, in relation to his information need statement.

Note.---Due to the wide variability of possible correct user responses, progress is monitored through the use of answers given to specific questions which are used to switch (or skip over) certain instructional material. Progress is not always performance-based as was noted in the first block of instruction.

Block three: search strategies. Only after the user has received appropriate training or has shown that he is knowledgeable of the concepts and materials offered in the first two blocks may he embark on block three, the most critical portion of the instructional sequence. Block three deals exclusively with the construction of the user's particular search strategy of interest. Subblocks and respective objectives are given in the following table:

Table 3

Subblocks and Objectives of Block 3 of EQUIP

Subblocks	Objectives
Selecting Descriptors	Using previously learned concepts, the user tentatively selects the descriptors he actually intends to use for his search strategy.
Logic Training	Using preselected descriptors from the previous subblock, all possible allowed logic sequences must be presented and understood by the user. It is at this point in the instruction that the user must indicate his understanding of the Boolean logic used by QUERY.
Estimating Hits Familiarization	The user must be cognizant of the possible list his set of descriptors will produce, given all possible Boolean logic operator combinations. If the user is not satisfied, he must have the option of either changing his descriptors or selecting a different logic pattern.

Block four: practice and submission. The fourth and final block of instruction provides the user unlimited practice in creating his actual search, encoding it, and, subsequently, submitting it as a job to the computer job stream. Additionally, a posttest is administered, scored, and recorded at the end of this block. Table 4 presents the subblocks and instructional objectives of block 4.

Table 4

Subblocks and Objectives of Block 4 of EQUIP

Subblocks	Objectives
Encoding the Search	The user must be given the opportunity to be actively involved in the encoding of his search.
Diagnostics Rework and Submission	Mechanical encoding errors must be detected and feedback given to the user as he learns to encode his search. The user must demonstrate competency in encoding his specific search of interest. The user's search request must be rejected by EQUIP if it fails the search language criteria of QUERY. If the strategy is acceptable, the user must be allowed to submit his search directly to the computer job stream.
Posttest	A means of ascertaining the user's newly acquired knowledge of automated information retrieval via QUERY and EQUIP must be accomplished.

The Instructional Sequence of EQUIP

EQUIP utilizes a flexible instruction sequence based on initial switching as a result of user responses to the eighteen pretest items provided in block one. A simplified flowchart of the sequenced decision system is presented in Figure 1. It should be noted that not all switching of the sequence is based on pretest responses. Additional switching is accomplished via binary choice questions requiring honest user responses. For example, if asked "Do you know how to use the rotated thesaurus?" the user must respond "No" to receive needed training. Work space limitations prevented total competency-based testing of the user's knowledge -- thus the "question and response" technique of controlling instruction sequence was necessary at times.

Figure 1

Major Instructional Sequence of EQUIP

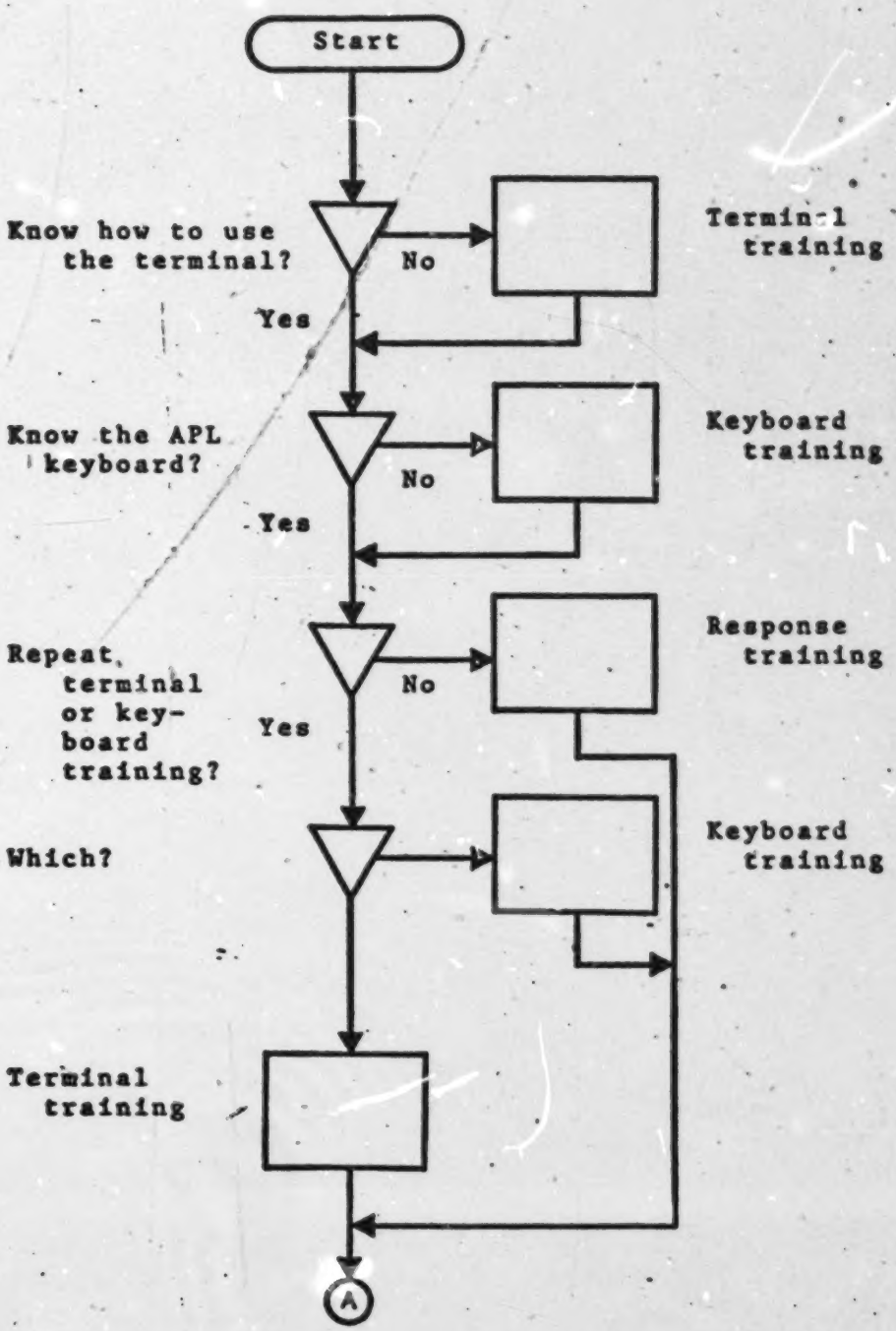


Figure 1 (Contd.)

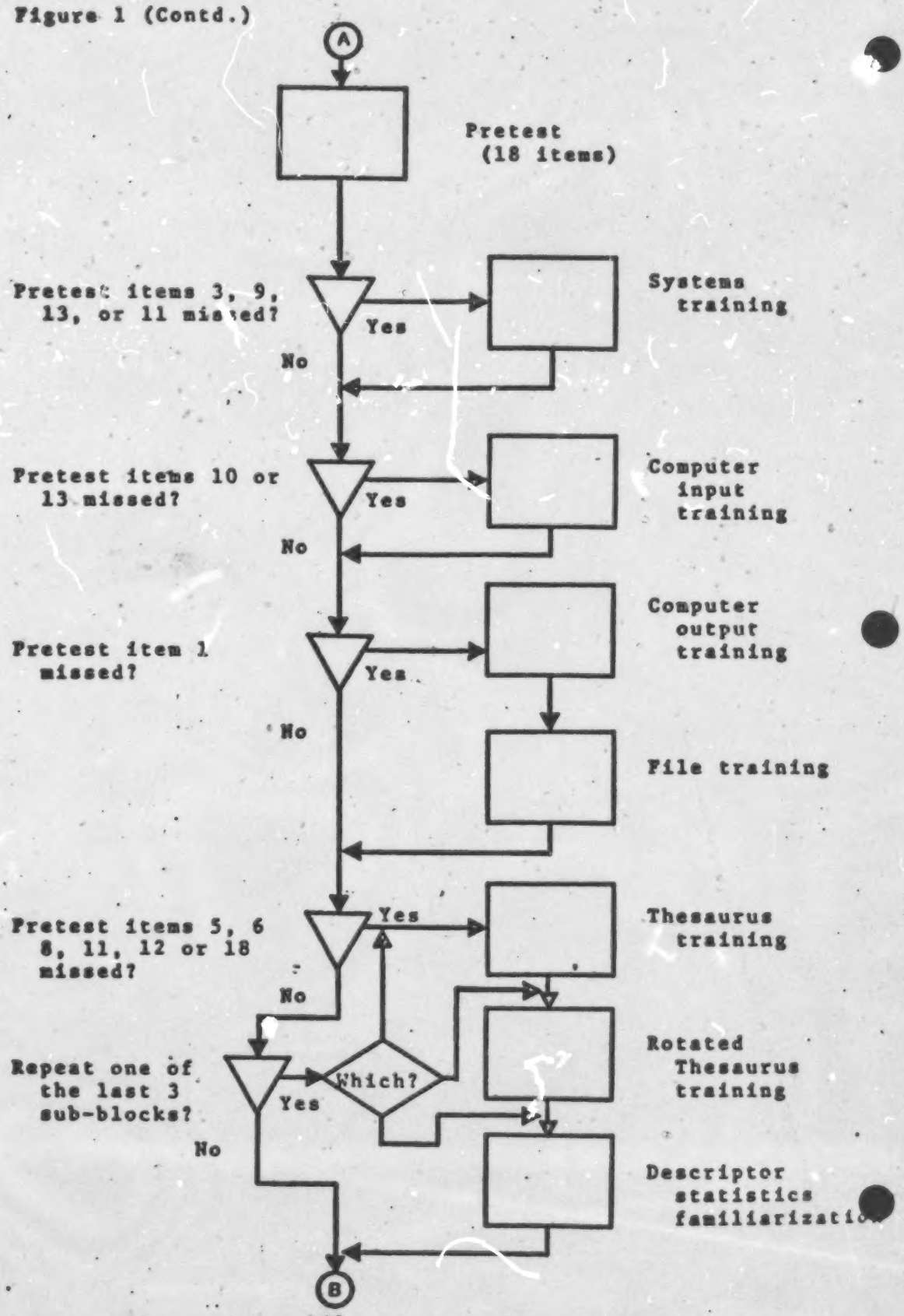


Figure 1 (Cont'd.)

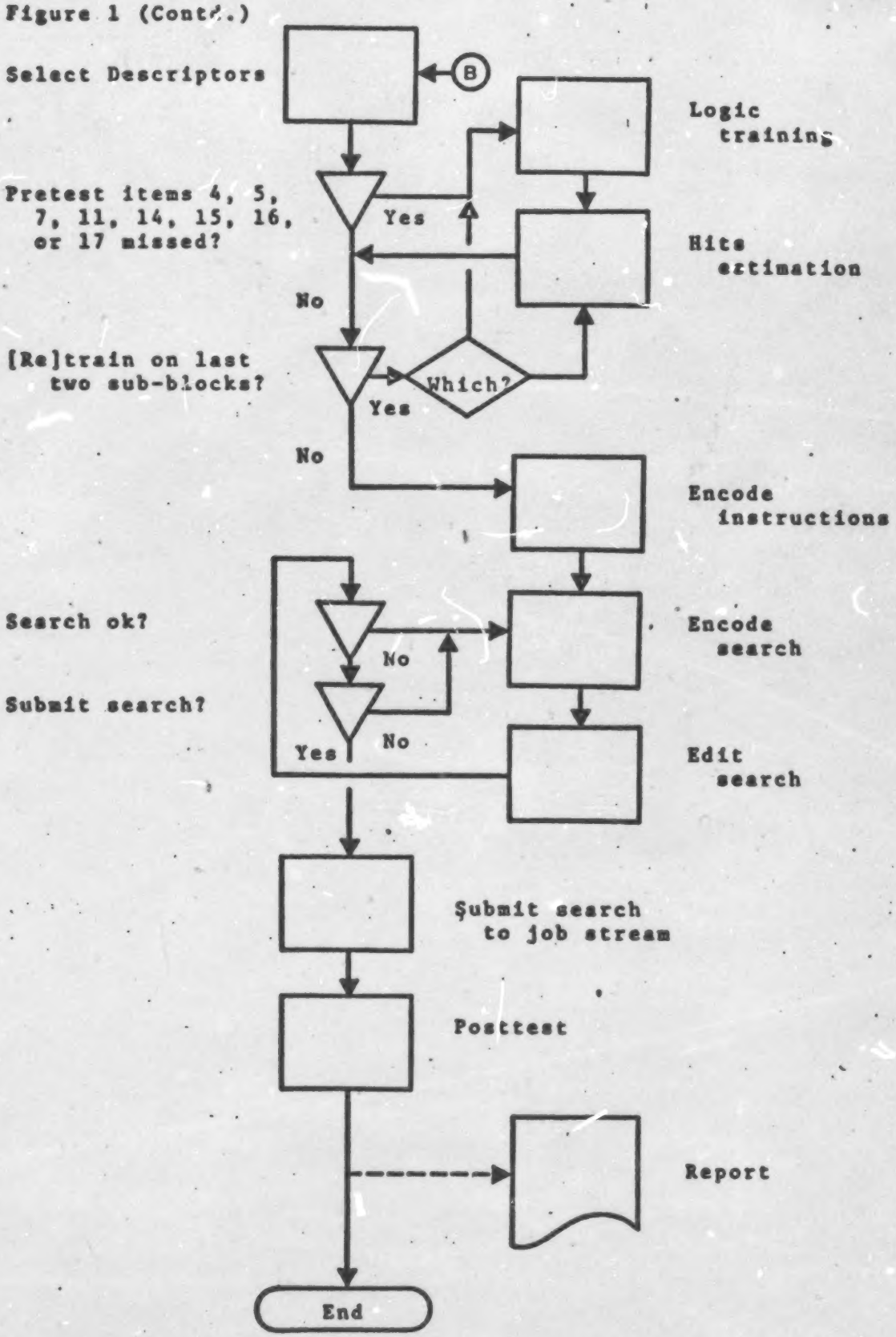
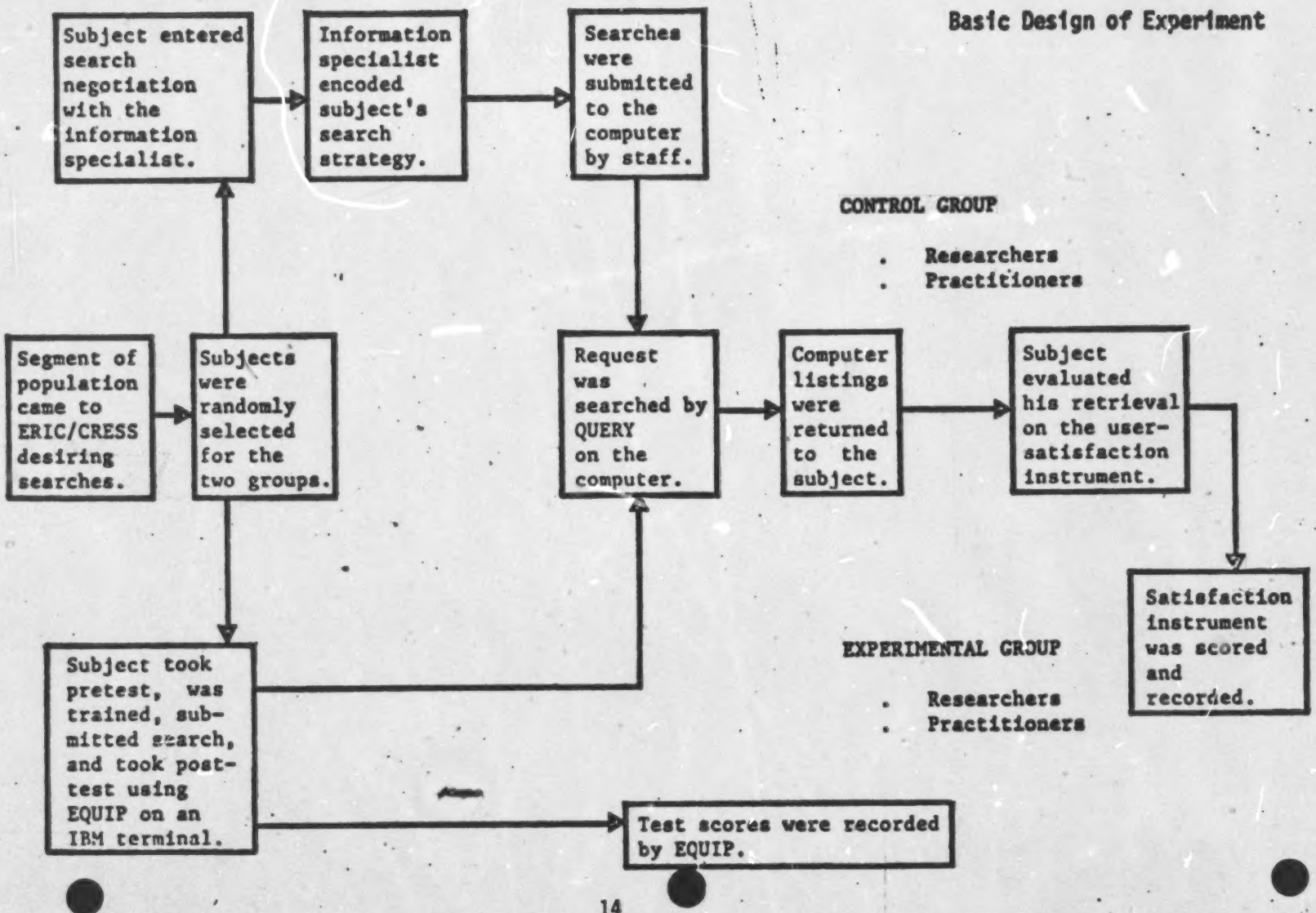


Figure 2

Basic Design of Experiment


Segment of population came to ERIC/CRESS desiring searches.
Subjects were randomly selected for the two groups.
Subject entered search negotiation with the information specialist.
Information specialist encoded subject's search strategy.
Searches were submitted to the computer by staff.
Request was searched by QUERY on the computer.
Computer listings were returned to the subject.
Subject evaluated his retrieval on the user-satisfaction instrument.
Satisfaction instrument was scored and recorded.
CONTROL GROUP
. Researchers
. Practitioners
EXPERIMENTAL GROUP
. Researchers
. Practitioners
Subject took pretest, was trained, submitted search, and took post-test using EQUIP on an IBM terminal.
Test scores were recorded by EQUIP.

DESIGN OF THE STUDY

The rationale of this study reduces to the following experimental question: After a CAI interface package has been created, is there any empirical evidence that its use with persons desiring information from the ERIC information base is effective? To phrase this question in another way: Is EQUIP as good as interface technique as existing search negotiation sessions with an information specialist?

Subjects desiring to use the ERIC/QUERY information retrieval system were divided into two groups -- control and experimental. The experimental treatments are graphically portrayed in Figure 2.

Both the experimental and control groups underwent a sequence of steps, shown as blocks in Figure 2, leading to the retrieval of a specific set of surrogated documents (citations) which were intended to meet individual information needs. As depicted in Figure 2, the control group sequenced (top activities) differed from that of the experimental group (bottom activities). Activities common to both groups are shown in the center of the paradigm. The activities which differ, search negotiations versus CAI training via EQUIP, were those of pivotal interest to the study. (See Figure 2 next page)

Sampling Design

The study population. The population from which the study sample was drawn consisted of that group of people who have a need for information in the educational realm and are researchers, practitioners, or in training for the same. Additional population characteristics were: (a) male or female adults, (b) multi-ethnic, (c) must not have used ERIC/QUERY system previously, (d) must have been accommodated by the ERIC/QUERY facility, (e) must have been willing to spend the appropriate amount of time necessary to accomplish a search in person, and (f) must have been aware of ERIC/QUERY facilities. There is no reason to believe that the population described here would be different from persons seeking similar information in other geographic locations of the nation.

Sampling technique. Since it was not possible to predefine a segment of the treatment population in terms of specific individuals, a modification of the systematic sampling method suggested by Sax (11, pp. 140-1), described in the subsequent paragraph, was used.

A total sample size of sixty, thirty in each treatment group, was deemed necessary. Prior to conducting the experiment, a sequential randomized sign-in sheet was created using the random number generator feature of APL. Persons coming to ERIC/CRESS[1] were required to sign in on the sheet described above. In this matter each subject was assigned to a treatment group at random.

[1] The ERIC clearing house, designated as ERIC/CRESS, at New Mexico State University was the site of the study.

Measures Employed

Because of the nature of the search negotiations process (the control treatment) it was impossible to administ a pre- or posttest to members of the control group to determine any gain of knowledge of the ERIC/QUERY system. Since EQUIP was designed to impart knowledge gain, pre- and posttesting was confined to subjects in the experimental group. By this procedure, it was possible to determine if EQUIP was a successful CAI tool.

To determine if any difference in user satisfaction of search effort was attributable to the experimental treatment, a second needed measure was accomplished at the termination of the treatment through the use of a user satisfaction questionnaire.

The Pre-Post Measure

It will be noted in the instructional sequence provided in Figure 1 that the pretest was administered to members of the experimental treatment group immediately after competency in the use of the terminal has been demonstrated by the subjects. Similarly, the posttest, which was identical to the pretest, was administered after the subject completes his training session on EQUIP.

Using Kuder-Richardson Formula 20, in the manner suggested by Sax (11, p. 161), the final session of the pre- and posttest used with the experimental treatment group had a reliability of .73. It should be noted that the EQUIP pre- and posttest instruments are "power" and not "speed" tests.

The user satisfaction instrument. The experimental design employed by this study required that a comparative measure of treatment groups be administered. Again, due to the nature of the study problem, it was impossible to administer a pretest observation to both groups. If a subject had not been served there would be no value to measuring his satisfaction with the service, since no service would have been received. Thus, there was a need for only a post-observational measurement to determine if the treatments used fostered any differences in satisfaction between treatment populations.

It was rationalized tht when a user arrives at ERIC/CRESS, he has several expectations related to his specific informtional need:

(1) He desires at least some hits as a result of his effort.
(2) He wants document citations which are relevant to his information need.
(3) He expects to expend time in his search effort.
(4) He expects ERIC/CRESS to assist in his search effort.
(5) He expects his total information research effort to be interesting, challenging, and useful.

The extent to which the user's information retrieval experience fostered positive and/or negative reactions within each of the criterial characteristics was measured with the simple Likert-type questionnaire. The questionnaire was created and tested with a small sample of subjects who had just received the results of an ERIC/QUERY computer search.

Sample characteristics. For the reasons discussed under sampling technique, until the collection of data was completed no specific description of the study sample could be provided. Only after the experiment was completed and subsequent descriptive analysis applied could the sample be more clearly identified.

There was a total of 31 men and 27 women in the sample; 16 men and 14 women in the control group, 15 men and 13 women in the experimental group.

AN OVERVIEW OF THE ANALYSIS

Comparison of User Satisfaction Item Means.

Treatment group scores obtained from the five Likert-type scales of the computer retrieval evaluation form were compared using the t statistic in the manner suggested by Winer (13, pp. 31-33) for comparing uncorrelated means of two groups with unequal n's. To test the assumption of homogeneity of variance for each measure, the appropriate F ratios were computed as suggested by Winer (13, pp. 33-6). The critical value for the two-tailed t statistic when $a = .05$ and $df = 56$ ($df = N_a + N_b - 2$) is $t_{.975}(56) = 2.04$, a value obtained from Winer's tables (13, p. 641). The F ratio critical value is $F_{.95}(28,30) = 1.87$ from the Chemical Rubber Company (CRC) Tables (2, p.308).

It was noted that the assumption of equal variance of group scores for item three lacked support. This necessitated additional analysis of this single measure. Accordingly, the computations for testing differences between independent sample means (13, p. 37) with unequal variances were applied to data collected for item three of the user satisfaction questionnaire. A summary of these calculations is given in Figure 3.

Figure 3

Summary Calculations of t' Statistic for Item Three of the Satisfaction Questionnaire

	Treatments	
	Control	Experimental
N	30	28
Means	3.7	3.11
Variance	.286	.592
$H_0: \mu_{c_3} = \mu_{e_3}$	$t'_{obs} = 3.188135$	
$H_1: \mu_{c_3} \neq \mu_{e_3}$	$c = .28735$	
	$f = 45.53$	

The values c and f are based on Welch's (13, p. 37) derivation and approximation of the Student's t distribution through a correction to the degrees of freedom which are used to ascertain the critical t value. Thus the critical value of t, using the appropriate conversion, becomes $t_{.975}(\mu) = t_{.975}(46) \cong 2.01$ for a two-tail test.

It can be seen that the computed t value was outside the $t_{.975}$ critical range. Thus it is concluded that there were differences manifested between the treatment populations as related to the amount of time spent obtaining search results.

Peformance of the Experimental Group

Pre- and posttest measures. To provide evidence that the CAI training and search submission program (EQUIP) did increase the knowledge of the user, the procedure suggested by Winer (13, pp. 39-43) for testing hypothesis between two means with correlated observations assuming a linear additive model was used. Calculations resulting in the values presented in Figure 4 were accomplished.

Figure 4

Summary of Calculations Comparing the Pre- and Posttest Interface Knowledge Gains of the Experimental Treatment Group

Hypothesis Tested	$\bar{X}_{post}$	$\bar{X}_{pre}$	$\bar{X}_{post} - \bar{X}_{pre}$	t_{obs}
$H_o: \mu_A = \mu_B$ $H_a: \mu_A \neq \mu_B$	79.786	34.071	45.714	14.09

Since $t_{.95}(28) = 2.05$, t_{obs}, $H_o: \mu_A = \mu_B$ is rejected and it is concluded that the difference of 45.714 points average gain from pre- and posttest measures could not have occurred by chance at $a = .05$.

Pre- and Posttest Scores Related to Satisfaction Score

The possibility of a simple linear regressive association between the pre- and posttest gains made by subjects of the experimental group and their respective total scores on the satisfaction questionnaire was accomplished. If a predictive relationship could be found to exist, additional support for the treatment effect on user satisfaction would be gained. Using the APL linear regression program MREG provided by the NMSU computer center which assumes the linear model $Y = XB + E$, two regression analysis procedures were accomplished. A summary of these efforts is presented in Figure 5.

Figure 5

Summary of Linear Regression Computational Results Relating to the Predictive Relationship of Posttest Scores and Pre- and Posttest Gains to Experimental Subject's Satisfaction Scores

Relationship	Dependent Variable	Independent Variable	B_0 (Intercept)	B_1 (Slope)	F-value (Regression)	R^2 (%)
Total Pre- and posttest gains to total satisfaction score	Total Satisfaction Score	Gain Score	19.67498	-0.08977	6.38*	19.71
Posttest score to total satisfaction score	Total Satisfaction	Posttest Score	18.4557	-0.03615	0.45	1.69

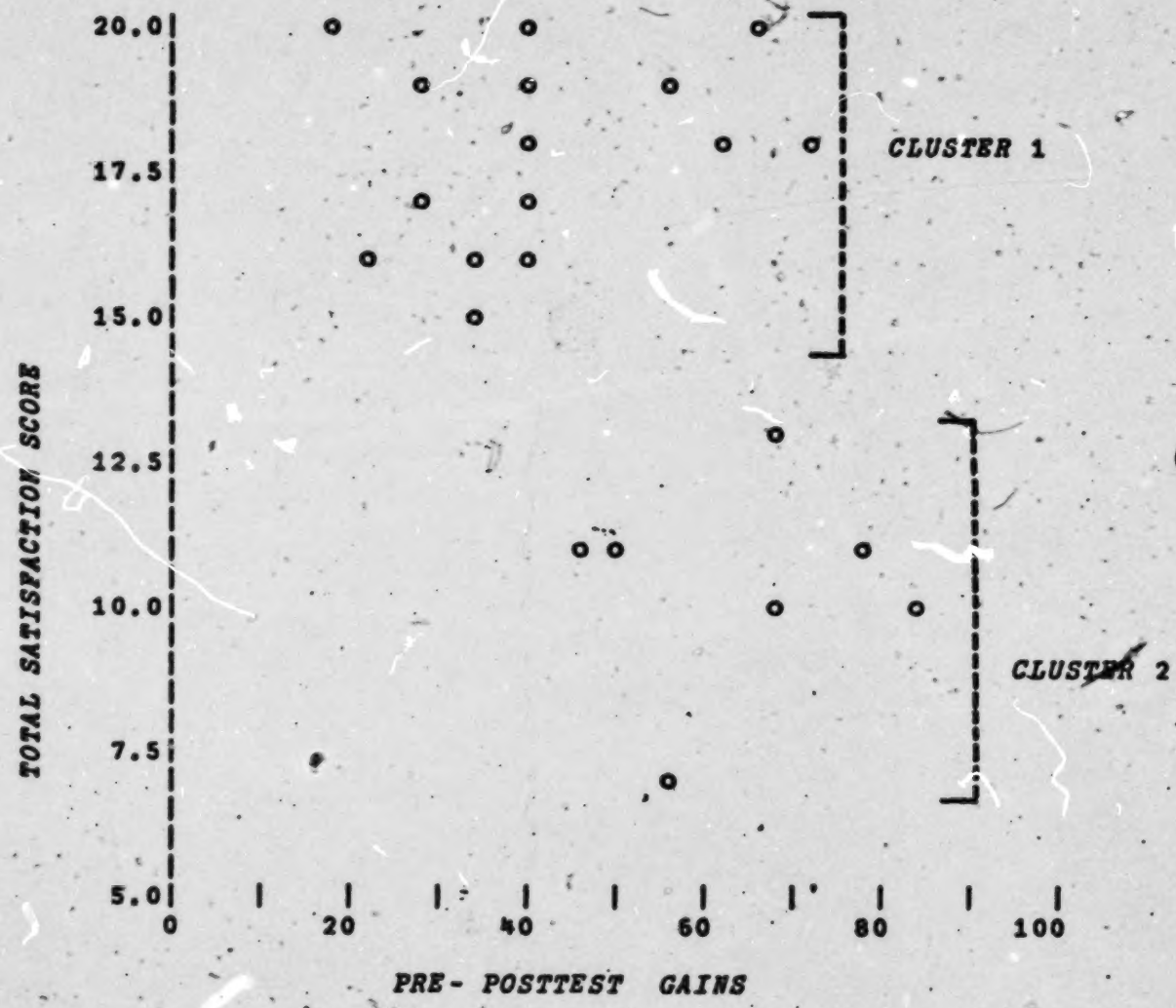
Critical F value = $F_{.95}(1,26) = 4.23$

*Exceeds critical $F_{.95}$ value of 4.23

505

Figure 6

Scattergram of Experimental Group Total Satisfaction Scores Versus Pre- and Posttest Gains



The results presented in Figure 5 agree with the scattergrams of the data. By inspecting the plotted values of pre- and posttest gains versus total satisfaction score, Figure 6, it is fairly obvious why the applied linear regression model accounts for only about 20 percent of the total variation -- very little if any pattern exists.

The previous discussion does not explain the significant regression manifested by the critical F value of the first calculation presented in Figure 5. By careful inspection of Figure 6 (scattergram of gains versus total satisfaction scores), two isolated clusters appear to exist, one in the top portion of the plot and a second in the bottom portion. It was felt that further investigation was warranted since the relationship of the total satisfaction scores to retrieval precision for the subjects isolated in the lower cluster of Figure 6 were highly correlated.

It is noteworthy that all of the subjects contained in cluster 2 obtain a search precision of zero with the exception of subject number 18 who obtained a precision of 100. There is evidence that this subject's satisfaction was low because, even though he obtained maximal precision on his search, he received only nine hits but was expecting over 50. From this, we conclude that the cluster of subjects providing a lower total satisfaction score were those who became disenchanted with the experimental treatment because they received less than expected results from their information retrieval effort, thus influencing the linear regression analysis shown to be significant in Figure 5. There is no reason to believe that this is the fault of the interface (EQUIP).

(See Figure 6 next page)

Basically the question that was asked was the effect of this small cluster of subjects obtaining low precision for their search efforts responsible for a significant negative slope of the B_1 line of the regression model? To investigate this possibility further, the two groups of subjects in question were separated and the linear analysis technique previously described was applied to each to determine if any regression effects existed for the isolated cluster. The results of these computations are provided in Figure 7.

Figure 7

Contrasted Linear Regression Summary Calculation
for Cluster 1 and Cluster 2 Subjects

Cluster	Dependent Variable	Independent Variable	B_0 (Intercept)	B_1 (Slope)	F-value (Regression)
1 (Top) N=21	Total Satisfaction Score	Gain Score	15.8401	0.364	1.75801
2 (Bottom) N=7	Total Satisfaction Score	Gain	9.636	0.0124	.0460

Critical F value for cluster 1 = $F_{.95}(1,21) = 4.30$
Critical F value for cluster 2 = $F_{.95}(1,7) = 5.59$

Supported by the analysis, it is concluded that the existence of a second different sample group within the experimental sample (cluster 2, Figure 6) is the cause of a significant regression effect at a = .05 when the entire experimental sample's dependent total satisfaction scores are predicted using a linear model. However, because the R^2 value of 19.7 indicates that the model accounts for only approximately 20 percent of the variability of the total sample responses, and because two clusters, both lacking any significant regression effect were shown to exist, evidence suggests that CAI knowledge gained does not significantly affect user's satisfaction with his search effort.

Additional Findings

In addition to the observational data applied to each of the experimental hypotheses previously discussed, careful records of the retrieval precision of each subject were maintained. The precision of a search effort is expressed as a ratio converted to a percentage of the number of retrieved hits to the total number of citations retrieved by the ERIC/QUERY system.

It was felt that analysis of user's precision values was worthwhile. More specifically, does the retrieval precision of an expert (the information specialist) differ from that of a novice (the experimental treatment sample)? More formally, this question may be stated as a statistical hypothesis: There are no differences between the average precision rates of users undergoing CAI training and submission via EQUIP and those obtaining the expert services of an information specialist.

To test this hypothesis, Student's t was applied, giving the results presented below.

Figure 8

Summary of Statistical Computation for Determining the Significance of Experimental Group Precision Means

X_c	X_E	$X_c - X_E$	t	F-ratio
58.2	52.679	5.521	.554	.667

Note.--The F_{obs} ratio does not exceed $F_{.95}(28,30) = 1.87$ and t_{obs} does not exceed $t_{.975}(56) = 2.04$.

Based on the non-significant value of t_{obs}, it is concluded that Ho: $\mu_e = \mu_c$ may not be rejected. It makes no difference whether a search is encoded by an expert or a novice trained on a CAI interface program; ERIC/QUERY retrieval precision is uniformly low -- about 55 percent.

INTERPRETATIONS OF EXPERIMENTAL RESULTS

Among treatments

To answer the pivotal issue of whether or not a specially constructed CAI interface program is viable, statistical tests were conducted to determine if population differences measured by the users' satisfaction responses existed. Each of these tests was described.

Statistical results of the testing procedure clearly indicated that the two interface methodologies did not cause any measurable differences in user's total satisfaction with the results of his search efforts. Analysis of individual items of the satisfaction questionnaire showed that, of the five, only one relating to the amount of time spent obtaining a search, measured any differences between the treatment populations. The experimental group was slightly less satisfied with the approximately two and one-half hours of time spent using the terminal as compared with control group members which spent less than thirty minutes in the search negotiation interview.

Within the experimental treatment

Examination of pre- and posttest gains of CAI interface users indicates that EQUIP did cause a significant increase in the novice user's ERIC/QUERY computer-searching skills. Surprisingly, however, there is no predictive relationship between such gains and the precision of the resulting searches when tested through linear regression techniques. Such a lack of predictability, it was felt, was due to the fact that precision attributes of ERIC/QUERY were such that, regardless of the computer-searching skill needed to execute a viable search strategy, precision rates remained less than ideal. To test this possibility, a separate analysis was conducted to determine if the search precision of assumed experts was equal to that of novice users trained on the telecommunication terminal. No difference between mean search precision of the two groups could be detected. This phenomenon may be due to any of three possibilities: (a) the novice users were as skilled as the information specialist; (b) regardless of skill, ERIC/QUERY is uniformly inefficient; or (c) a combination of both. Unfortunately, no empirical evidence may be brought forth which rectifies this issue; however, the results of the precision test between groups supports the use of EQUIP.

In addition to conducting linear regression analysis to determine possible predictive relationships between EQUIP gain scores and user satisfaction, separate regression analysis was conducted for two cluster groups shown to exist within the sample -- those subjects with very low retrieval rates (cluster 2) and all others (cluster 1). Due to the existence of the second cluster, it is evident that total satisfaction scores, and thus the significance of total subsample regression line, is effected, since separate regression analysis for each cluster was determined to be nonsignificant. This clearly shows the effect of some users' resulting search precision on their overall satisfaction of search effort -- an understandable situation since users do want access to information.

CONCLUSIONS

Based on the procedures and analyses of collected data within the scope of the study, the following specific conclusions were formulated. These generalizations are confined to the specific population used in the study.

The CAI Interface

It is not only possible to use a CAI-medium tele-processing interface with which to bring novice users into direct contact with a complex computerized information retrieval system, but such an interface method (EQUIP) was created and demonstrated to function just as well as the search negotiations method in use at many installations. It was also demonstrated that populations of users classified as researchers or practitioners, based on pre-search retrieval expectations of the system, are both accommodated with the CAI interface in terms of their satisfaction with literature-searching efforts. Thus, the CAI interface services both types of users equally well.

The Effectiveness of EQUIP

Although EQUIP is one of many possible approaches to training users to submit a computer literature search, the significant pre- and posttest means coupled with the fact that all of the subjects in the experimental group were able to submit a search which was not rejected by the system clearly demonstrates the viability of such an interface method. It is concluded that EQUIP, as an interface process, did meet the objective for which it was created.

General

Tests of two of the three main study hypotheses designed to examine relationship between the experimental and treatment population resulted in the inability to reject the null hypotheses; i.e., no differences were found between the experiment groups within the dimensions studied. It is concluded that the CAI interface method, when used in conjunction with ERIC/QUERY, was no more nor less effective than search negotiations interface (which requires the use of "data processing types") even though knowledge gains were shown to exist among EQUIP users.

IMPLICATIONS

The Use of EQUIP

For the past two years the user desiring ERIC/QUERY retrieval services had as his only alternative for initiating a search, the services of an information specialist -- a situation which is manifested in most computerized information retrieval systems desiring to continue receiving the advantages of batch processing. With the application of a CAI training and search submission interface, a new alternative has been demonstrated. The time utilized by an information specialist to initiate searches for users may confidently be relegated to the user and the computer. The number of users accommodated may be increased in direct proportion to the number of accessible telecommunication terminals available; thus a larger number of information seekers may gain access to information retrieval files at a time when the information need is critical.

It should be noted that the use of EQUIP, or similar CAI training and submission programs, is not limited to the ERIC/QUERY system. Interface systems such as EQUIP may be used with any batch processing system if minimum hardware and software requirements are provided.

RECOMMENDATIONS

The implementation of the concept of using a pre-dedicated, interactive systems mode to bring the educator (or anyone else for that matter!) directly into contact with the computer and, at the same time, not directly relying on the system's personnel time and services, may be considered a progressive step towards "humanizing" the data processing environment. Much has been done by many, as on-line systems have emerged. However, there is one very important ingredient that tends to make the interface system more attractive -- cost.

It is felt that the alternative presented in this paper will become very attractive once cost comparisons between the EQUIP-type interface systems are compared and contrasted with existing on-line dedicated systems. It is emphasized that no empirical cost comparisons were attempted in this study. This appears to be the next logical step, although the alternative offered here seems to be approximately 90% less costly than, for example, DIALOG (an on-line retrieval system which accesses the same ERIC files as EQUIP.)

Finally, many educators are becoming increasingly concerned about claims by data processing personnel that the computer can be used to accomplish the tasks at the same costs as "old traditional" methodology. Educators have been heard to retort: "...but we aren't happy with what we are doing now. Give us alternatives which do things better!" If EQUIP-type interface systems are to be judged in light of the above, educators must, at least, attempt their use.

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